CLAIMS

What is claimed is:

1. An optical structure comprising:

a substrate; and

a plurality of two-sided optical components, each side of each component having optical microstructures, the components being disposed along the substrate, wherein at least a portion of one side of at least some of the components is air-backed and the other side of the at least some of the components is substantially wetted-out by a material.

2. The optical structure of Claim 1 wherein the microstructures include at least one of cube-corner prisms, diffractive structures, cube-corner prisms, diffractive structures and lenses, lens arrays, prism arrays, linear Fresnel lenses, lenslets, alphanumeric characters, digital structures, colored structures, color shifting structures, textured structures, moth-eye structures, linear prisms and lenses, lenslets, and fish-eye lens arrays.

3. The optical structure of Claim 2 wherein the substrate is a first substrate and wherein the cube-corner prisms are disposed along a plurality of second substrates.

4. The optical structure of Claim 3 wherein at least some of the cube-corner prisms are spaced apart along at least one of the second substrates.

5. The optical structure of Claim 3 wherein the cube-corner prisms and the second substrates are formed from holographic, luminescent, colored, and/or diffractive material.

6. The optical structure of Claim 2 wherein the cube-corner prisms include different size cube-corner prisms.

7. The optical structure of Claim 2 wherein at least some of the cube-corner prisms are tilted with respect to an optical axis of the cube-corner prisms.

8. The optical structure of Claim 7 wherein the cube-corner prisms include at least two different tilt angles.

9. The optical structure of Claim 3 wherein the cube-corner prisms of one second substrate overlap at least some cube-corner prisms of another second substrate to tilt at least some of the components with respect to the first substrate.

10. The optical structure of Claim 3 further including a color pattern formed on at least part of at least some of the cube-corner prisms to provide colored retroreflected light.

11. The optical structure of Claim 10 wherein the color pattern includes at least two colors.

12. The optical structure of Claim 10 wherein the color pattern includes at least one standard color, at least one fluorescent color, or a combination thereof.

13. The optical structure of Claim 3 further including a color pattern formed between the cube-corner prisms and the second substrate to provide colored retroreflected light.

14. The optical structure of Claim 1 wherein the substrate includes at least one adhesive selected from a group consisting of a substantially transparent heat-activated or substantially transparent pressure-sensitive adhesive.

15. The optical structure of Claim 14 wherein the adhesive includes a substantially transparent color.

16. The optical structure of Claim 14 wherein the adhesive is disposed along a substantially transparent top film.

17. The optical structure of Claim 16 further comprising a carrier film disposed along the substantially transparent top film.

18. The optical structure of Claim 14 wherein at least some of the two-sided optical components are partially embedded within the adhesive to substantially wet-out one side of at least some of the components, the other side of the at least some of the components being air-backed.

19. The optical structure of Claim 18 further comprising a backing layer disposed over the air-backed side of the at least some components.

20. The optical structure of Claim 19 wherein the backing layer is substantially transparent for forming a transflector.

21. The optical structure of Claim 19 wherein the backing layer is bonded to the adhesive at selective locations.

22. The optical structure of Claim 21 further comprising a substantially transparent top film disposed along the adhesive, wherein the backing layer is bonded to the substantially transparent top film at selective locations.

23. The optical structure of Claim 22 wherein the backing layer is bonded to the adhesive through heat sealing, radio frequency sealing, ultrasonic sealing, or hot lamination techniques.

24. The optical structure of Claim 14 wherein the adhesive has the same index of refraction as material that forms the plurality of two-sided components.

25. The optical structure of Claim 1 wherein the substrate includes a liquid-curable coating.

26. The optical structure of Claim 25 wherein at least some of the plurality of two-sided optical components disposed along the substrate are partially embedded within the liquid-curable coating to substantially wet-out one side of the at least some components, the other side of the at least some components being air-backed.

27. The optical structure of Claim 26 wherein pressure is used to partially embed the components within the coating.

28. The optical structure of Claim 25 further comprising a substantially transparent top film disposed along the liquid-curable coating.

29. The optical structure of Claim 25 wherein the liquid-curable coating has the same index of refraction as material that forms the plurality of two-sided optical components.

30. The optical structure of Claim 1 wherein the plurality of two-sided components are positioned on the substrate, the optical structure further comprising a fill layer covering the components wherein air pockets are formed between the substrate and the components.

31. The optical structure of Claim 30 wherein the fill layer bonds the components to the substrate.

32. The optical structure of Claim 31 wherein the fill layer bonds directly to the substrate between the components.

33. The optical structure of Claim 30 wherein the fill layer has a sufficiently high viscosity so that it does not flow underneath the components.

34. The optical structure of Claim 33 wherein the fill layer has a viscosity of about 30,000 to 50,000 centipoises.

35. The optical structure of Claim 31 wherein the components retroreflect light incident upon the fill layer.

36. The optical structure of Claim 30 wherein the substrate includes a fabric.

37. The optical structure of Claim 1 wherein the substrate includes a fabric and the components are disposed within the fabric, the optical structure including a

coating disposed over a first side of the fabric to wet-out a first side of at least some of the components.

38. The optical structure of Claim 1, wherein the optical structure includes a thermoplastic material, a thermoplastic material, or a combination thereof.

39. The optical structure of Claim 38, wherein the thermoplastic is selected from the group consisting of polybenzimidazole, polyaryletherketones, polyetherketone, polyetherketoneketone, polyetheretherketone, polyphenylene sulfide, polyinide, polyetherimide, polyamideimide, polyester, polybutylene terephthalate, polyethylene terephthalate, polycyclohexamethylterephthalate, liquid crystal polymer, sulfone polymer, polysulfone, polyethersulfone, polyphenylsulfone, and polyamide.

40. The optical structure of Claim 1, wherein the optical structure includes polyurea.

41. A method for forming an optical structure having a microstructured surface on at least one side, comprising disposing a plurality of two-sided optical components along the substrate, each component having optical microstructures on each side, wherein at least a portion of one side of at least some of the components is air-backed, the other side of the at least some of the components being substantially wetted-out by a material.

42. The method of Claim 41, wherein the material includes the substrate.

43. An optical structure comprising:

a substrate;

a plurality of two-sided retroreflective components positioned on the substrate; and

a fill layer covering the components wherein air pockets are formed between the substrate and a bottom surface of at least some of the components.

44. A method for forming an optical structure comprising:

providing a substrate; and

providing a plurality of two-sided optical components along the substrate, wherein at least one side of substantially all of the components is air-backed and the other side of substantially all of the components is substantially wetted-out.

45. The method of Claim 44 wherein the components include cube-corner prisms and wherein the substrate is a first substrate, further comprising providing the cube-corner prisms along a plurality of second substrates.

46. The method of Claim 44 wherein the substrate includes a substantially transparent adhesive selected from the group consisting of heat-activated adhesive and pressure-sensitive adhesive and wherein the two-sided components are partially embedded within the adhesive to wet-out the other side of substantially all of the components.

47. The method of Claim 46 further comprising a backing layer disposed over the air-backed side of the components for forming a transflector.

48. The method of Claim 47 wherein the substrate includes a liquid-curable coating and wherein the plurality of two-sided components disposed along the substrate are partially embedded within the liquid-curable coating to wet-out the other side of substantially all of the components.

49. The method of Claim 48 wherein pressure is used to partially embed the components within the coating.

50. The method of Claim 48 further comprising a substantially transparent top film disposed along the liquid-curable coating.

51. The method of Claim 44 wherein the components include cube-corner prisms and wherein the plurality of two-sided retroreflective components is positioned on the substrate, the retroreflective structure further comprising a fill layer covering the components wherein air pockets are formed between the substrate and the at least one side of substantially all of the components.

52. The method of Claim 51 wherein the fill layer bonds the components to the substrate.

53. The method of Claim 52 wherein the fill layer bonds directly to the substrate between the components.

54. The method of Claim 51 wherein the fill layer has a sufficiently high viscosity so that it does not flow underneath the components.

55. The method of Claim 44 wherein substantially all of the components include barbs.

56. The method of Claim 55 wherein the substrate includes a fabric and the components are disposed within the fabric and held in place by the barbs.

57. The method of Claim 56 further comprising a coating disposed over a first side of the fabric to wet-out the other side of substantially all of the components.

58. A retroreflective structure comprising:

a fill layer; and

a plurality of two-sided retroreflective cube-corner prism components disposed within the fill layer, wherein one side of the components has a reflective coating thereon.

59. The retroreflective structure of Claim 58 wherein light passes through the two-sided cube-corner prism components until it is reflected by the reflective layer.

60. An optical structure comprising a first substrate and a second substrate, each substrate having a plurality of microstructures disposed on a surface, the first substrate being positioned relative to the second substrate with the microstructures from the first substrate facing the microstructures from the second substrate with at least some air space disposed there between.

61. The optical structure of Claim 60 wherein the first and second substrates include extending members which extend from the substrates and bond to one another.

62. The optical structure of Claim 60 further comprising a layer disposed between the first and second substrates.

63. The optical structure of Claim 61 further comprising a layer disposed between the first and second substrate and the extending members bonding to at least a portion of the layer.

64. The optical structure of Claim 60 wherein the first substrate is attached to the second substrate around a periphery of the optical structure.

65. The optical structure of Claim 60 wherein the first substrate is attached to the second substrate by bonding the plurality of microstructures from the first substrate to the plurality of microstructures from the second substrate.

66. The optical structure of Claim 60 further comprising a plurality of optical structures suitable to be mixed into a coating or binder.

67. An optical structure comprising a plurality of microstructures enclosed within an outer layer that is formed from a single substrate.

68. The optical structure of Claim 67 wherein the microstructures include cube-corner prisms, surface relief diffuser structures, and/or micro-lens structures.

69. The optical structure of Claim 67 wherein the outer layer includes a hollow tube extruded around the microstructures.

70. The optical structure of Claim 67 wherein the microstructures are formed on an inside surface of the outer layer, after which the outer layer is formed into a hollow tube.

71. The optical structure of Claim 67 wherein the outer layer is substantially circular, square, rectangular and/or oblong-shaped in cross-section.

72. The optical structure of Claim 67 wherein at least some of the microstructures have air spheres therein.

73. The optical structure of Claim 67 wherein the same material that forms the microstructures extends through the outer layer to an outside surface of the structure.

74. The optical structure of Claim 67 wherein the outer layer and/or the microstructures are/is colored.

75. The optical structure of Claim 67 further comprising a plurality of structures disposed in a coating.

76. The optical structure of Claim 67 further comprising a plurality of structures disposed on and/or in at least one polymer.

77. The optical structure of Claim 67 further comprising a plurality of optical surfaces woven in a fabric mesh.

78. The optical structure of Claim 67 further comprising a plurality of optical structures attached to a film.

79. The optical structure of Claim 67 wherein the optical structure is formed from a high temperature material.

80. A method for forming an optical structure comprising encasing a plurality of microstructures within an outer layer that is formed from a single substrate.

81. The method of Claim 80 wherein the microstructures are formed on an inside surface of the outer layer, and the outer layer is formed into a hollow tube.

82. The method of Claim 80 wherein the structure is formed by an extrusion process.

83. The method of Claim 81 wherein the structure is formed by forming apertures in the outer layer, hereafter the microstructures are cast on the outer layer wherein

material that forms the microstructures fills the apertures and extends to an outer surface of the structure.

84. The method of Claim 80 further comprising texturing, coloring, and/or providing a moth-eye structured surface on the outer layer.

85. The method of Claim 80 wherein the optical structure is formed by a progressive injection molding process.

86. A method for forming an optical structure, comprising:

injecting a material into a mold to form the optical structure;

forming the optical structure into a desired geometric shape; and

sealing ends of the optical structure.